

Selection of approach and fixation in the treatment of type C fracture of distal humerus in adults

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【Abstract】 Objective: To study the surgical treatment for distal humeral fractures in adults according to the follow-up results.

Methods: Twenty-one cases (16 males and 5 females) of distal humeral fracture were included in this study. The average age was 42.5 years (range: 37-52 years). Fractures were classified according to the AO classification system. Nine cases of C1, 8 C2 and 4 C3-type fractures were identified. Open reduction and internal fixation were performed in all cases. A triceps-reflecting approach was adopted, and either the AO orthogonal plating or parallel plating technique was chosen, based on the fracture type. The plaster cast was removed 3 weeks after operation. Rehabilitation was en-

couraged during this period and afterwards. The average follow-up time was 12.2 months (range: 8-28 months). The outcome was scored according to Aitken and Rorabeek system.

Results: No nerve injury, nonunion or failure of fixation was encountered during the operation and follow-up. However, ossifying myositis occurred in one case.

Conclusions: A triceps-reflecting approach can provide adequate exposure to the joint. The use of AO orthogonal plating or parallel plating techniques based on the type of fractures can provide rigid fixation for the fracture.

Key words: *Humeral fractures; Intra-articular fractures; Surgical fixation devices*

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Unlike the common distal humeral fracture in children, the prevalence of fractures at this site is not high in adults and accounts for only 2% of all fractures. Moreover, intraarticular fractures, especially the type C fracture, are rare and usually caused by high energy injury. After fractures occur, there are problems of disconnection between the condyles and diaphysis, and of disruption between the medial and lateral condyles. The two condyle fragments rotate along their own axes and the trochlea is usually intact. All these factors create difficulties for reduction and fixation. The currently employed surgical approaches are usually not able to provide enough exposure, and sufficient stability can not be achieved by internal fixation to allow early functional exercises. There are still difficulties in the management of intra-articular fractures of the distal humerus in adults.^{1,2} Our objective is to study

the surgical treatment for distal humeral fractures in adults by patients' follow-up.

METHODS

General data

Twenty-one cases (16 males and 5 females) of distal humeral fracture were included in this study. The average age was 42.5 years, ranging from 37 to 52 years. Fractures were classified according to the AO system, including 9 cases of C1, 8 C2 and 4 C3. There were 2 cases of open fracture. The main causes of fractures were falling from height and traffic accidents. There were no patients with nerve or vessel injury, and no osteofascial compartment syndromes at presentation. The average time from injury to the beginning of the operation was 10 hours.

Surgical method

Under brachial plexus block or tracheal intubation anesthesia, the patient was positioned laterally with the arm draped over a bolster to allow extensive flexion of the elbow. The affected shoulder and elbow were flexed at a 90 degree angle. A longitudinal posterior skin incision was made on the midline of the upper

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arm. The ulnar nerve was identified and protected. The medial aspect of the triceps was elevated from the humerus. Sharpey's fibers were sharply released from the olecranon. The proximal ulnar periosteum was split and freed along the medial margin of the olecranon without total dissection. The proximal ulnar periosteum, distal triceps and tendon were reflected and retracted radially after capsule incision. The fractures at the condyles and trochlea were fully exposed. In order to expose the trochlea extensively, the elbow was flexed fully and the olecranon was retracted with a towel clamp when necessary.

An AO double plate was selected for type C1 and C2 fractures. Two 3.5 mm reconstruction plates were placed on the posterior side of the ulnar column and the lateral side of the radial column in distal humerus respectively, and fixed with screws. One more screw was needed to cross the fracture line from the posterior side of the radial column. For the treatment of type C3 fractures, the parallel plate was selected. The articular fragments were fixed with thin K-wires after anatomic reduction. Two 3.5 mm reconstruction plates were positioned at the medial side of the medial column and lateral side of the lateral column, and fixed with screws. Compression was achieved for supracondylar fractures.

Postoperative treatment

The elbow was immobilized, by a plaster splint, at 90 degrees of flexion with the forearm in neutral position for 3 weeks. Three days postoperatively, the plaster was removed for 2 hours a day to practice elbow flexion and extension exercises. Subsequently, the plaster was totally removed and active functional practice was encouraged.

RESULTS

There were no complications of nerve or vessel injury during operation. No infection, nonunion or failure of internal fixation was detected at follow-up. Myositis ossificans occurred in one case. According to the Aitken and Rorabeek evaluation criteria,³ the clinical results were excellent in 10 cases, good in 7 cases, acceptable in 2 cases and unacceptable in 2 cases. The good to excellent rate was 80.9%.

DISCUSSION

The average age at surgery in this series was 42.5 years. According to the mechanism of injury, fractures are divided into flexion and extension types. The flexion type is often due to a fall from a height which causes a fracture when the elbow flexes during landing. The injury energy is rather low, so the fracture type is usually C1 or C2, and the trochlea is intact with minor soft tissue injury. The second type of injury is extension type. The force is loaded on an extended forearm, the ulnar olecranon impacts the trochlea, or the force is applied to the elbow directly, causing supracondylar and intercondylar fractures and comminution of the trochlea. The fracture type is usually C2 or C3 if the injury energy is high. Sometimes these fractures are open with severe soft tissue damage and early edema. The fracture type and injury mechanism are vital to surgery timing, prognosis evaluation and complication prevention.

A posterior approach to distal humeral fracture is generally selected at present. This approach can achieve exposure of both condyles and protection of ulnar nerve. There is still no widely-accepted proposal for triceps management. The commonly used approaches are triceps splitting, triceps sparing and olecranon osteotomy.^{4,5} The first two approaches break the integration of triceps with greater damage and consequent longer healing time, potential adverse effects on postoperative function, and higher prevalence of myositis ossificans. Olecranon osteotomy provides better exposure, but there are also complications of nonunion and internal fixation failure after surgery. In our series, the incision was made along the medial margin of the medial triceps head. Sharpey's fibers were sharply released from the olecranon. Along with the proximal ulnar periosteum, they were reflected and retracted radially. This triceps-reflecting approach is called Bryan-Morrey approach.^{6,7} The potential advantage is to protect the triceps maximally with minimal extension mechanism injury, so that patients could begin early postoperative exercise.

Of course, adequate exposure is the first aspect to consider in terms of approach choice. The irregular structure of the distal humerus and defects caused by loss of bone mass in trochlea and olecranon fossae make precise reduction difficult. The degree of expo-

sure determines the outcome of reduction. Wilkinson⁵ compared the exposure area of the distal humeral articular surface in different approaches and found that the percentage of median exposed articular surface for the triceps splitting, triceps reflecting, and olecranon osteotomy approaches was 35%, 46% and 57%, respectively. The triceps reflecting approach provides limited exposure, but it is better than triceps-splitting approach. We held and retracted the olecranon with a towel clamp and extensively flexed the elbow to enhance the exposure of the trochlea. The olecranon osteotomy provides better exposure for type C3 fracture of the trochlea, comminution, and bone defects. In short, the triceps reflecting approach does not cross the neurologic interface and can protect the extensile mechanism maximally and permit early functional exercises after surgery, so the elbow extensor strength can be reserved early. At the same time, full exposure can be used for distal humeral fractures, elbow joint release and replacement. The reported main complication in literature is the lateral dislocation of elbow extension devices postoperatively. In our series, the triceps tendon was fixed to the olecranon in a horizontal drilling, so that no such complications occurred.

As for the selection of internal fixation, we used a Y plate for a period, and found that this plate was appropriate for single fracture and high supracondylar fracture. In the intraarticular fractures, the plate was placed posterior to the condyles, so the screws were not long enough to reach the anterior parts from posterior ones. On the other hand, if the distal humerus was irregular, the Y plate had an inconsistent angle at the divergent point for the inter-condylar angle, resulting in occupation and influence on the inter-condylar fossa.

When type C1 and C2 fractures are simple without obvious comminution, we recommend a double plate system, which can provide enough strength for fixation. The 90-90 plate is widely recommended and proved to provide rigid strength. We suggest that the ulnar plate be placed to the posterior aspect of medial condyle and the radial plate to the posterior-lateral aspect of the lateral condyle, so that the screws are placed in different directions. A lag screw is inserted through the fracture lines from the posterior aspect of the lateral

column in order to improve stability (Figure 1). The configuration of the plate and screw can easily control the dislocation of fracture and improve the stability.

As reported by Sanchez-Sotelo,⁸ we chose a parallel plate to treat type C3 fractures. The key surgical points are as follows. The plates are placed to the medial and lateral aspects of the distal humerus, forming an arcade structure. Long screws increase the purchase strength. The screws pass through the fracture lines and are used to fix as many fragments as possible. All screws pass through the plate to enhance the stability. The trochlea is fixed with 3-4 screws, forming a stable special composition. We found that the parallel plates increased the fixation stability. Functional practice is encouraged, with soft tissue edema diminished 3 days postoperatively. In some cases, the casts can be removed. Some related reports have demonstrated that this fixation provides advantage in mechanical strength.⁹ But this is technique demanding, since the reconstruction plate is precontoured preoperatively according to a model to decrease the operating time. The operating design should be meticulously planned preoperatively, including the fragment size and number, the screw direction and length, to avoid interruption between screws (Figure 2).



Figure 1. Type C2 fracture (AO classification). A 90-90 plate was used for reduction immobilization. The ulnar plate was placed on the posterior aspect of the medial condyle, and the radial plate on the posterior-lateral aspect of the lateral condyle. A lag screw was inserted through the fracture lines from the posterior aspect of the lateral column in order to improve the stability.



Figure 2. Type C3 fracture (AO classification) treated by parallel plate technique. The plates were placed on the medial and lateral aspects of the distal humerus, forming an arcade structure.

The good to excellent rate of 89.9% is still lower than that reported in the literature. We suggest that this difference lies in rehabilitation method. Pain is the main deterrent to the functional exercise. When we performed local block anesthesia to prevent postoperative pain, the effect and efficiency were greatly improved. Other patients had elbow extension difficulty, which may be due to inaccurate fracture reduction. Moreover, the stability of internal fixation available now is not strong enough for fracture fixation. The anatomical characteristics of the distal humerus hinder the stable internal fixation, providing a clue that a more reasonable fixation method and system is required.

In conclusion, a tricep-reflecting approach can provide adequate exposure to the joint. The use of AO orthogonal plating or parallel plating techniques based on the fracture types can provide rigid fixation of fracture.

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